NASA Science Mission Directorate

Earth-Sun System Division – Applied Sciences Program

Decision Support through Earth Science Results – Cooperative Agreement Notice

NASA partners with national organizations and Federal agencies to extend NASA Earth science research results into decision support tools to benefit U.S. and global citizens. This solicitation requested projects in two areas: a) projects to integrate NASA Earth science research results (e.g., spacecraft observations, model outputs) into decision-making in twelve areas of national priority (through Integrated System Solutions), and b) projects to improve organizational networks of Earth science institutions so public, private, academic, and nonprofit sectors can harness Earth science research results to meet national needs (through Solutions Networks).

NASA received 94 Step 2 proposals in response to this solicitation – NASA selected 19 Integrated System Solutions proposals and 2 Solutions Networks proposal for awards, totaling approximately $20 million over the three-year life of the projects. Projects will aid the nation by demonstrating the capacity to extend benefits of Earth science results for improved decision support on national issues, including water management, public health, air quality, ecosystem stewardship, and disaster management. The objective for all the projects is to extend the uses of NASA Earth science research results to benefit society.

The NASA Applied Sciences Program website has additional information about the program:
http://science.hq.nasa.gov/earth-sun/applications

Graeme Aggett / Riverside Technology, Inc
Enhancing Water Management Decision Support Systems with High Spatio-temporal Resolution Mapping of Actual Evapotranspiration.

Consistent, accurate and detailed information on water consumption by agricultural crops has been a long-

standing critical need in river and water resources management. Quantification of consumptive use (evapotranspiration-ET) is increasingly important as water resources are placed under growing tension by increased users and interests. Scarce water supplies can be managed more efficiently through use of comprehensive real-time information and prediction tools, and accurate and timely information. Crop ET is a large component of the water balance in agricultural areas of the arid west. The focus of the proposed work is to develop multi-temporal and spatial scale ET application prototypes to augment decision support capabilities and increase operational efficiencies of two water management decision support systems, SPDSS and RiverWare. The proposal describes a method for estimating real-time ET demand using NASA Earth-Sun system research results. The proposed methodology solves the surface energy balance equation using the reflectance and temperature bands of satellite imagery and provides instantaneous ET estimates on a pixel-by-pixel basis, which are in turn related to an instantaneous reference estimation from a weather station. Based on this relationship weekly, monthly and seasonal ET estimates can be computed for each pixel and aggregated by area, crop type, or diversion structure. Prototype applications will be developed in two locations: Colorado (SPDSS), and Washington State (RiverWare). Benchmarking evaluation tests will be developed and implemented to identify, measure and report the degree of enhancement afforded to the respective DSS. An internet map serving and analysis capability will be developed by RTi to streamline the flow of data into both DSS. Numerous activities throughout the grant period will be aimed at systematically building a transition approach that guarantees the enhanced DSS has life beyond NASA support. Extension of the DSS enhancements will be facilitated by partnerships developed with agricultural-water management extension agents regionally, nationally and internationally.

Francisco Chavez / MBARI
Utilizing remote sensing, modeling and data assimilation to sustain and protect fisheries: ecological forecasting at work

Successful ecological forecasting of fishery yields in the face of climate variability has eluded resource managers for decades. However, recent advances in observing systems, computational power and understanding of ecosystem function offer credible evidence that the variability of the ocean ecosystem and its impact on fishery yield can be forecast accurately enough and with enough lead time to be useful to society. The tools are now in

place to provide ocean managers the capability to both protect and wisely use living marine resources. Advances in space-based real time sensors, high performance computing, very high-resolution physical models, and robust ecosystem theory make possible operational forecasts of both fish availability and ecosystem health. Accurate and timely forecasts can provide the information needed to maintain the long-term sustainability of fish stocks and protect the ecosystem of which the fish are an integral part, while maximizing social and economic benefits and preventing wasteful overinvestment of economic resources. We propose to enhance the current decision support system for the small pelagic fishery and upwelling ecosystem in the coastal ocean off Peru with remote sensing information and state-of-the-art coupled physical-biogeochemical three dimensional ocean models to provide operational forecasting and improve ecosystem management. This region is the best in the world for this implementation because it has the world's largest single-species fishery, the Peruvian anchovy, which is supported by the world's most variable ocean ecosystem. This variability is forced mainly by well understood climate variability. Because of the global importance of both the climate variability and the anchovy fishery, there are in place in this region well developed monitoring and decision support systems. No other ocean region has this combination of environmental observations, fish resources, fisheries monitoring and well validated climate forecast models for forcing high-resolution operational ecosystem models. Once implemented for the Peruvian anchovy fishery, these tools will be ported to decision support systems for fisheries along the US West Coast and made available to others working in similar environments of the world ocean.

Robert Crabtree / Yellowstone Ecological Research Center
Integration of a Large-Area Invasives Spread Network (LISN) with Climate Models for Decision Support

The Yellowstone Ecological Research Center of Bozeman, Montana proposes to integrate a Large-area Invasives Spread Network (LISN) to the existing United States Geological Survey (USGS) decision support system (DSS) known as the National Invasive Species Forecasting System (NISFS). Year one of LISN was recently funded and work is just now beginning; the enclosed proposal seeks funding for years two and three of this important work. We will apply remote sensing-based ecological models for the prediction of invasive species and pathogen spread over regional spatial scales. Our models will incorporate climate data and allow predictions under various climate scenarios. The program, which fits under the Integrated System Solutions component of the CAN solicitation, primarily addresses two of 12 applications of national priority¿Invasive Species and Ecological Forecasting¿and

focuses on enabling the use of NASA data and resources in an existing federal partner DSS. More specifically, the work will enhance the current NISFS DSS as planned (Schnase et al. 2002) by adding: - Predictive invasive spread modeling to the current static modeling efforts; - Incorporation of climate variables and predictions from the NASA-CASA carbon-climate model; - Large-area, regional geographic extent via study of a fourth, far larger area¿the Greater Yellowstone Area (GYA)¿to current NISFS prototyping efforts; - New and repeated taxonomic coverage, including an invasive pathogen; and - New avenues of applicability by partnering the existing USGS DSS with the US Fish and Wildlife Service (USFWS) to provide ecological forecasting tools for threatened and endangered (T&E) species.

Eurico D'Sa / Louisiana State University

A GULF-COAST MONITORING AND HAZARDS DECISION SUPPORT TOOL - ENHANCEMENTS USING NASA EARTH SCIENCE PRODUCTS, DATA AND MODELS

Coastal regions in the northern Gulf of Mexico such as the Louisiana, Mississippi, and Texas coast are under the combined threat of subsidence, wetland loss, energetic meteorological events and human induced changes to the ecosystem. Emergencies such as the landfall of a hurricane, or an oil spill can have a strong impact on a coastal ecosystem or community. For example, the landfall of hurricane hurricanes Katrina and Rita have considerably impacted coastal communities and ecosystems, reduced the capacity of oil industry, with consequences felt by the US economy and throughout the world. In such a fragile environment, emergencies pose complex decision problems. To address this issue, both state and Federal Governments have passed legislations to address these emergencies associated with storm surge and mitigate loss of coastal wetlands and ecosystems. A storm surge decision support tool (DST) in operation for coastal Louisiana and Mississippi utilizes field data from the Wave-Current-Surge Information System (WAVCIS) at Coastal Studies Institute (CSI), Louisiana State University (LSU) which provides near real-time field met-ocean data (wind, currents, temperature, sea level and waves). Information from the WAVCIS system will be enhanced to include data from NDBC buoys along the Louisiana and Texas coast and the assimilation of several NASA Earth science products and data: i) winds from Seawinds on QuickSCAT, ii) sea surface temperature (SST), total suspended matter (TSM), Chlorophyll (Chl), Colored Dissolved Organic Matter (CDOM), and reflectance data from MODIS on Terra and Aqua, and iii) Sea Surface Height (SSH) from Jason-1. The output of an NRL nested coastal model (NCOM) of the Gulf coast (that uses

NASA measurements) will be integrated into the DST to provide 3-D ocean currents, temperature, salinity and sea level variations at 20 levels and a resolution of about 2 km for near-shore coastal waters. The enhanced DST using model and NASA results will provide information on storm surge, and effects (e.g., saltwater intrusion, flooding, water quality) on near-shore coastal environments (e.g., bays, wetlands), and change detection (associated with subsidence, sea level rise or vegetation change). The use of Geographical Information System (GIS) for monitoring the near-shore changes will provide managers and users with an efficient tool for decision making. Our objectives are to use a system engineering approach to critically re-evaluate relevant NASA results and assure its integration into the DST. We plan to develop a web site with integrated GIS and database capabilities for wider access and dissemination of information. Benchmarking the existing DST and transitioning to a Gulf Coast system by integrating the NASA products and model to multiple users (e.g., WAVCIS, National Data Buoy Center-NDBC, National Wetland Research Center-NWRC, Louisiana Department of Natural Resources-DNR, and Mineral Management Services-MMS) will leverage funding and facilitate the integration of NASA Earth science data for coastal management and decision making. Implementation of this system in an environment dominated by the largest river system in North America will potentially allow for its transition to other deltaic regions and optimize the use of NASA Earth-Sun System science research results to meet national needs. The project will also provide the research structure and financial support for training undergraduate and graduate students.

Mike Doherty / North Olympic Peninsula Resource Conservation and Developme
Evolving a Solutions Network of Resource Conservation and Development Councils, Watershed Management Teams, and NASA Research Institutions Across the Nation.

The North Olympic Peninsula (NOP) Resource Conservation and Development Council (RC&D) proposes to evolve a Solutions Network of local, regional and national organizations to provide watershed management teams with decision support through NASA-funded earth-sun research results. The NOP-RC&D was selected to lead the project because the Natural Resource Conservation Service (NRCS) administers an existing network of 375 RC&Ds across the nation. The NOP-RC&D and NRCS will work with the NASA-funded Pacific Northwest Regional Collaboratory to apply hydro-climatological research to improve the scientific basis of local watershed decision making. The Dungeness River watershed was selected as a demonstration site for testing the proposed

Solutions Network because local citizens pioneered one of the states most cooperative, effective and integrated water, ecosystem and agricultural management teams. The performance of this local Solutions Network will be optimized and a blue print for extending these activities and results broadly across the nation will be developed.

Eugene Fosnight / USGS National Center, EROS
Improving decision support tools and decision-making processes for renewable energy planning and assessment using NASA Earth-Sun Systems data and modeling results

The Solar and Wind Energy Resource Assessment (SWERA) DSS was designed, implemented and populated with funding from the Global Environment Facility. The SWERA archive and DSS is supported by the United Nations Environment Program to foster the development of clean energy to minimize the risk of climate change and to improve energy security. The existing SWERA DSS serves 13 countries and consists of disparate renewable energy data streams and decision support tools created and maintained by the SWERA partners. The SWERA web site and archive is built on an open source standard's compliant architecture. Web mapping and graphing services allow SWERA assessments to be visualized and queried, and provide an interface to renewable energy toolkits. This proposal seeks to enhance the existing SWERA DSS by (1) serving countries beyond the 13 SWERA nations by providing direct access through the SWERA DSS to NASA's Earth-Sun System research results from the global capacity of the NASA SSE/POWER project, (2) deriving hydropower assessments derived from SRTM digital elevation data and rainfall estimates derived from the TRMM sensor building on existing USGS and U.S. Agency for International Development (USAID) hydrology and energy projects, and (3) closely couple the NASA data stream with renewable energy analysis and investment toolkits, HOMER and RETScreen, maintained and supported by National Renewable Energy Laboratory and Natural Resources Canada, respectively. The NASA POWER research results provide renewable energy information for the entire world. This data provides a vital source of information to countries with no access to publicly available national renewable energy assessments and also provides information needed to create national renewable energy assessments and plans. The newly available SRTM elevation data and rainfall estimates derived from the TRMM sensor provide the capacity to create hydropower assessments in developing countries that are now only available in the developed countries with high resolution elevation data and establish stream flow monitoring systems. This proposal uses Earth-Sun System research results to impact three national priorities: energy management, carbon

management and water management. Clean energy solutions reduce emissions and removal of biomass. Small hydropower systems also reduce the environmental impact to riparian ecosystems caused by large hydropower structures.

Andrew Hansen / Montana State University
Ecological condition of US National Parks: Enabling decision support through monitoring, analysis, and forecasting

Anthropogenic changes in land use and land cover pose one of the foremost threats to resources in U.S. National Parks. To track in ecological condition, the US National Park Service has initiated a decision support system within the new NPS Inventory and Monitoring Program (NPS I&M). The goal of this project is to increase the effectiveness of the NPS I&M DSS by the delivery, analysis, forecasting, and display of NASA ESS data, models, and science results. We will collaborate with the NPS to: 1. Select landscape-level indicators of NPS "vital signs" and identify the boundaries of the greater park ecosystem appropriate for these indicators. 2. Establish procedures to directly incorporate existing products from NASA-sponsored Terrestrial Observation and Prediction System (TOPS) and other sources. 3. Add value to these products for NPS management by using ecological knowledge to guide the analysis and portrayal of changes in land use/cover, climate, ecosystem productivity, hydrology, and biodiversity, and to forecast likely ecosystem changes given alternative decision scenarios. 4. Integrate the data acquisition, analysis, forecasting, and display of these ecosystem changes into the NPS I&M's DSS framework. We will focus on four NPS I&M Networks that were selected to provide a broad range of park characteristics, environmental situations, and types of impacts from land use change. We will implement fully functional prototypes in each network. To do so, we will use a conceptual model of parks as subsets of larger ecosystems to evaluate and refine NPS indicators and to quantify the surrounding greater park ecosystem. We will supplement the NPS I&M DSS through the delivery of 22 products from TOPS in operation at NASA Ames Research Center. This will include the automated retrieval, processing, and integration of NASA ESS data sets, including those from the AQUA, TERRA, and Landsat platform sensors. TOPS component ecosystem models will be used to develop historical baselines of ecosystem conditions for the period 1885-2005 and provide forecasts to 2025 under alternative scenarios. Close collaboration by the NPS helps ensure the smooth transition of project findings and technology to NPS I&M Networks. Software development will use ESRI products to accommodate NPS

staff, who are skilled in the use of ArcGIS software. The NPS has contributed 6 mos/yr of senior staff time and substantial cost share from NPS I&M scientists to ensure that project activities remain well aligned with the Inventory and Monitoring Network and agency needs for ecosystem monitoring, operations support, and interpretation. This project promotes NASA's goals by making NASA ESS data more available and relevant to the NPS. It will provide an integrated solution that improves the management of national parks, a highly visible use of NASA's products, and will promote an active and ongoing partnership with NPS. This project will provide benefits to many Americans, of whom more than 400,000,000 visit national parks each year.

Jan Hendrickx / New Mexico Tech
What is the value of integrating best estimates of regional evapotranspiration into hydrologic decision support systems?

Monitoring of regional evapotranspiration allows decision makers (i) to follow where, when, and how much water has moved into the atmosphere by evapotranspiration; (ii) to monitor crop performance and the effects of droughts for famine prediction; (iii) to better evaluate the performance of irrigation systems; and (iv) to improve weather predictions. The overall goal of this proposal is to determine the value of integrating best estimates of regional evapotranspiration from NASA earth science results into two existing decision support systems: the Agricultural WAter Resources Decision Support (AWARDS)/ET Toolbox system developed by the US Bureau of Reclamation and the Gridded Surface/Subsurface Hydrologic Analysis (GSSHA) model developed by the US Army Corps of Engineers. Two different implementations of the Surface Energy Balance Algorithms for Land (SEBAL) are used in the proposed study. SEBALNM is an adaptation of SEBAL developed at New Mexico Tech by PI Hendrickx for assessment of evapotranspiration rates in the heterogeneous riparian valleys of the southwestern United States. The algorithm Mapping Evapotranspiration at High Resolution with Internal Calibration (METRICTM) has been developed at the University of Idaho by Advisor Allen for precise mapping of evapotranspiration of irrigated fields and rangelands. SEBALNM and METRICTM need as input at least one emissivity in the thermal infrared band and reflectances in the visible, near-infrared, and mid-infra bands. Therefore, the NASA sensors to be used are limited to Landsat, MODIS, NPP, and NPOESS. The performance indicator for this study is how well regional evapotranspiration and river flows are predicted.

Michael Hesse / NASA Goddard Space Flight Center

Integrated forecasting system for mitigating adverse space weather effects on the Northern American high-voltage power transmission system

Abstract: We propose to develop a prototype forecasting system for mitigating the potentially adverse effects of solar activity on the North American high-voltage power transmission system. The forecasting system will consist of a chain of models, which transmit plasma and magnetic fields and their dynamics from the solar surface and heliosphere, to the magnetosphere of the Earth, and then into the Earth's ionosphere. Geomagnetically induced currents (GIC) flowing in the power transmission system and the geoelectric field driving GIC will be derived from these ionospheric currents. The induced currents within the power transmission system will then be compared to measurements of the Electrical Power Research Institute's (EPRI) SUNBURST network (e.g., http://www.epriweb.com/public/000000000001011779.pdf) for metrics, validation, and verification analyses. Models employed by the proposed forecasting system are resident at the Community Coordinated Modeling Center (CCMC, (http://ccmc.gsfc.nasa.gov) located at the NASA Goddard Space Flight Center in Greenbelt, Maryland. These models, which have been developed using NASA resources by the space research community, have been provided to the CCMC for research simulation and evaluation of space weather applications, such as the one described by this proposal. The model chain will be driven by solar data from NASA missions such as SOHO, or from ground-based observatories. Additionally, NASA's ACE spacecraft, which is located upstream from the Earth, will provide a second source of driver data for the magnetosphere/ionosphere component of the model chain. The proposed activity will consist of the following elements: - Assembly of a complete model chain, with interchangeable components, covering the propagation of solar disturbances from the Sun to the Earth’s upper atmosphere. - Derivation of the geoelectric field and the resulting GIC in the power transmission system from ionospheric currents. - Execution of the model chain for stormy space weather conditions. - Generation of draft forecasts based on solar data inputs and ACE solar wind data through the application of both real-time quality (level 1) and validated (science quality) driver data. - Determination of forecast accuracy by means of direct comparisons with the GIC data provided by the SUNBURST network. Perform detailed validation and verification studies that compare forecasted to measured GIC. - Evaluation of the economic impact and value of mitigation effects that can result from increased solar forecast availability. - Re-evaluation of model components to determine the most effective model combination, for both solar and near-Earth (ACE) data inputs. -

Recommendations for the most effective GIC forecasting system that can be constructed using modern space science models, as well as an implementation strategy, according to value and validation studies.

Paul Houser / Institute of Global Environment and Society, Inc.
WaterNet: The NASA Water Cycle Solutions Network

Earth is a unique, living planet due to the abundance and vigorous cycling of water throughout the global environment. Water is essential to life and directly impacts and constrains society's welfare, progress, and sustainable growth, and is continuously being transformed by climate change, erosion, pollution, and engineering practices. The water cycle is a critical resource for industry, agriculture, natural ecosystems, fisheries, aquaculture, hydroelectric power, recreation, and water supply, and is central to drought, flood, transportation-aviation, and disease hazards. It is therefore a national priority to use advancements in scientific observations and knowledge to develop solutions to the water challenges faced by society. NASA's unique role is to use its view from space to improve water and energy cycle monitoring and prediction. NASA has collected substantial water cycle information and knowledge that must be transitioned to develop solutions for all twelve National Priority Application (NPA) areas. Therefore, we propose to develop WaterNet: The NASA Water cycle Solutions Network, whose goal is to improve and optimize the sustained ability of water cycle researchers, stakeholders, organizations and networks to interact, identify, harness, and extend NASA research results to augment decision support tools and meet national needs. We will develop WaterNet by engaging relevant NASA water cycle research resources and community-of-practice organizations, to develop what we term an "actionable database" that can be used to communicate and connect NASA Water cycle research Results (NWRs) towards the improvement of water-related Decision Support Tools (DSTs). An actionable database includes enough sufficient knowledge about its nodes and their heritage so that connections between these nodes are identifiable and robust. Recognizing the many existing highly valuable water-related science and application networks, we will focus the balance of our efforts on enabling their interoperability in a solutions network context. We will initially focus on identification, collection, and analysis of the two end points, these being the NWRs and water related DSTs. We will then develop strategies to connect these two end points via innovative communication strategies, improved user access to NASA resources, improved water cycle research community appreciation for DST requirements, improved policymaker, management and stakeholder knowledge of NASA research and application products, and

improved identification of pathways for progress. Finally, we will develop relevant benchmarking and metrics, to understand the network's characteristics, to optimize its performance, and to establish sustainability. The WaterNet will deliver numerous pre-evaluation reports that will identify the pathways for improving the collective ability of the water cycle community to routinely harness NWRs that address crosscutting water cycle challenges.

Cathy Kessinger / NCAR
Oceanic Convective Weather Diagnosis and Nowcasting

Deep convection over the oceans presents a safety hazard to aircraft and is a costly impediment to efficient flight routing across long oceanic routes. The Convective Diagnosis Oceanic (CDO) and Convective Nowcasting Oceanic (CNO) products, under development within the FAA Aviation Weather Research Program (AWRP) Oceanic Weather Program Development Team (OW PDT), will help to mitigate these impacts by providing real-time, current and predicted locations of convection. Using these products, pilots, dispatchers and controllers will be able to assess the distribution of oceanic clouds and efficiently plan flight tracks that avoid regions where convective hazards may exist. As a result, the exposure of oceanic traffic to damaging turbulence, lightning and icing will be minimized. Inclusion of NASA Earth science data sets into the CDO/CNO products will improve their performance through better understanding of the atmospheric and oceanic environments, better wind vector measurements, and by providing a second independent verification data set.

Marc Kramer / UC Santa Cruz
Explicit Biological Control Agent Modeling of Invasive Species Using NASA Remote Sensing and Micro Climate Models

This proposal describes work that will combine existing USDA and NASA modeling systems to allow critical biological models of invasive species and their control to be assessed and improved for long-term sustainable ecosystem management. It addresses not only biotic factors such as plant phenology and growth but also insect biological control agent impact, and control effectiveness. In doing so, it outlines a partnership between UC Santa

Cruz, USDA-Agricultural Research Service and NASA-Ames to newly adapt, test, verify, validate and benchmark the incorporation of NASA remote sensing and spatial modeling technology into critical USDA efforts for invasive species management. This work was designed through an extensive and interactive scoping process with end field users, invasive species regional managers and national coordinating bodies such as the National Invasive Species Council, and the Secretary of Agriculture's Office. These entities and other cooperating groups are participating in the overall use and assessment of this new technology. In overview, the combined UC Santa Cruz, USDA and NASA team will work with cooperators to adapt NASA technology to improve existing USDA biological models for two high priority invasive plant species and their control agents. While the current generation of USDA biological models are unique in their capability and provide vital decision support tools for and the biology and control of invasive species, they currently lack explicit spatial simulation capability and detailed environmental inputs that NASA technology can provide. Therefore we anticipate that our proposed enhancements will significantly improve existing USDA capabilities in predicting and combating invasive species at local, regional and national levels where these new models are expect to be used. Specifically, the team plans to utilize NASA MODIS feature track wind data products and SeaWinds scatterometer sensors on board the Aqua, Terra and Quickscat satellites in conjunction with NASA microclimate models. These will be linked with USDA biological models and ground-based assessments to provide end users with spatially explicit predictions of insect population and plant growth and spread. These results will be used by field practitioners and other program elements in the USDA to assess invasive weed impact and control efforts over wide areas, to plan future control measures on a watershed or larger basis and to assess the effectiveness of controls, through space and time. Specifically, we will demonstrate improved capability for modeling the spread of and simulating biological control effectiveness for yellow starthistle and saltcedar at select sites across the Western United States. Finally, a transition plan was developed that will be funded principally through the USDA and initiated in year 3. This implementation program is expected to continue thereafter through the USDA invasive species office and its state and regional cooperators.

Brian Lamb / Washington State University
A Comprehensive Regional Air Quality Decision Support System in the Pacific Northwest

This work seeks to improve existing meteorological, air quality and smoke forecasting systems by infusing them

with NASA Earth System Science results. The projects proposed for satellite data enhancement are the MM5 numerical weather forecast system, the Air Indicator Report for Public Awareness and Community Tracking (AIRPACT) Eulerian air-quality forecasting system and the ClearSky agricultural field burn smoke forecasting systems, three projects of the Northwest Air Quality Environmental Science & Technology consortium (NW-AIRQUEST). NASA Earth-Sun system research products offer potential improvement in meteorological modeling underlying all of our air quality (AQ) modeling, initial and boundary conditions for AQ modeling, and verification and evaluation. Two principal uses for Earth-Sun system research products (ESRP) are planned: (1) Improving forecast accuracy through use of more representative and spatially resolved boundary and initial conditions (and emissions) for both meteorological and atmospheric chemistry variables for the meteorological and AQ models, and (2) improving system evaluation through comparison of model results with ESRP data, for example comparison of forecast winds with ESRP winds and comparison of column abundances of pollutants species with model results. The ESRP satellite instrument products sought are: ¿ GOES water-vapor and cloud track and QuikSCAT SeaWinds Scatterometer winds ¿ Terra MISR Leaf Area Index and Fractional PAR for phenology of vegetation ¿ Terra MOPPIT and Aura OMI tropospheric retrievals for ozone and carbon monoxide ¿ Forest-Service-STI BlueSky RAINS project MODIS-derived fire emissions ¿ Terra (or Aqua) MODIS column aerosol mass.

Yao Liang / Virginia Tech, Alexandria Research Institute
Enhancing NOAA AWIPS DSS by Infusing NASA Research Results for Drought and Other Disaster Management

The core mission of the U.S. National Weather Service (NWS) is the protection of life and property and, thereby, the enhancement of the national economy. A major element of this mission is water-related disaster forecasting. The NWS carries out its mission through its national centers and operational field offices, the latter including its 13 River Forecast Centers (RFCs). The Advanced Weather Interactive Processing System (AWIPS) was implemented by NWS in the 1990s to support its decision making in issuing all forecasts, watches, and warnings. A sub-Decision Support System (DSS) of the AWIPS is the NWS River Forecast System (NWSRFS). The Ohio RFC, the focus of the proposed project, uses the NWSRFS to provide forecasts of floods and droughts, two major natural hazards in the Ohio River Basin that have major impacts on the region’s agriculture, industries,

commercial navigation, and residential communities. Improvements to the forecast accuracy of NWSRFS, derived from the infusion of NASA satellite soil moisture data, through NASA-NOAA land surface models, are thus expected to have a significant economic as well as human impact. The proposed project focuses on improving the evapotranspiration (ET) input to the NWSRFS, through an innovative spatial data assimilation framework, recently developed by the University of California at Berkeley. This framework, using NASA satellite surface soil moisture data in conjunction with the NOAH model, will significantly improve the ET input to NWSRFS and, thus, the latter's forrecasting skill for disaster management. This integration of NASA spacecraft measurements and NASA/NOAA models into the NWSRFS will be effected by the extension of an equally innovative Hydrological Integrated Data Environment (HIDE), a prototype of which was recently developed by Virginia Tech. The automated flow of NASA satellite data into HIDE will be ensured by leveraging the expertise of the Goddard Earth Sciences Data Information and Services Center (GES DISC). The project’s integrated system solution will enable NWSRFS to seamlessly avail itself of the improved ET product and, thus, enhance its capability for drought and flood disaster management. A rigorous systems engineering approach will ensure the verifiable and benchmarked integration of project results into the NWSRFS, thus enabling its likely sustained, post-project adoption of these results. The proposed project is aligned with, and contributory to, NASA participation in the U.S. Group on Earth Observations (USGEO), specifically the IEOS Near-Term Opportunity, National Integrated Drought Information System. The project’s integrated system will notably contribute towards progress along the NASA Application of National Priority, Disaster Management.

Julie Lundquist / Lawrence Livermore National Laboratory
Integrating NASA Earth Science Capabilities into the Interagency Modeling and Atmospheric Assessment Center for Improvements in Atmospheric Transport and Dispersion Modeling

An Integrated System Solution (ISS) for improved Atmospheric Transport and Diffusion (ATD) modeling of potential biochemical and nuclear hazards is proposed in support of the United States lead Federal agency for incidents of national significance. The Department of Homeland Security's Interagency Modeling and Atmospheric Assessment Center (IMAAC) at Lawrence Livermore National Laboratory, in partnership with the NASA Goddard Space Flight Center and the NASA Stennis Space Center, propose to integrate and benchmark the inclusion of satellite-derived data products into the suite of IMAAC models, focusing initially on aerodynamic

roughness length, in order to improve their performance and to enhance decision support during potential atmospheric release events. The suite of IMAAC models, including meteorology and transport models, are the Decision Support Tools (DSTs) employed by IMAAC. IMAAC has asked NASA to focus on providing spatially distributed roughness length, one of the most important parameters in ATD modeling. Incorporation of roughness length into IMAAC will serve as a prototype for other secondary model parameters available from NASA. The proposed project relates to the Homeland Security application of national priority. Other applications, such as Air Quality and Disaster Management will also benefit from the project's results.

John McHenry / Baron Advanced Meteorological Systems
Assimilating AURA-derived Trace Gas Retrievals into an Operational Multipollutant Ensemble Air Quality Forecast Decision Support System with a Focus on Ozone and Haze Prediction

We propose a 3-year project enabling the use of NASA Earth-Sun System results in an existing air quality forecast decision support system (AQF-DSS). We will improve operational ozone and haze forecasts by assimilating retrieved tropospheric-NO2 from AURA/OMI and (recently upgraded) aerosol optical depth (AOD) from MODIS. After benchmarking the improvements, we will disseminate the improved forecasts to end users nationally on a sustained basis. The end-user/ decision-makers include multiple state/local air quality forecast agencies, the DOE, the National Park Service, the VISTAS regional planning organization, and over 200 broadcast meteorologists and the general public. The AQF-DSS is runs operationally at Baron Advanced Meteorological Systems (BAMS) using an ensemble modeling system that includes CMAQ and MAQSIP-RT driven by MM5 or WRF, along with the SMOKE emissions models. A data-assimilation module will be prototyped, verified, and validated enabling the new satellite data to be ingested into the AQF-DSS. We will utilize surface PM2.5 and ASOS data to augment the satellite data and improve the vertical resolution of the retrievals. We will upgrade coupled emissions and land-surface model science by adopting the NASA Land-Information System (LIS) to provide improved relative humidity forecasts and reconcile LU/LC representations with biogenic emissions, consistent with recent GEOSS expert panel co-convened by the project PI. The Visibility Improvement State and Tribal Association of the Southeast (VISTAS) RPO will provide model data from its 2002-annual CONUS CMAQ-aerosol visibility simulation for data-assimilation algorithm evaluation. Real-time access to surface data and data processing will be performed through the DataFed system, maintained

at Washington University/St. Louis. The project will validate and benchmark the improvements gained through adoption of the NASA ESS results, will share datasets with USGEO and other relevant NASA partners, and will sustain the improved system indefinitely. BAMS has assembled an outstanding team of scientists and engineers led by PI John N. McHenry - who pioneered operational-commercial air quality forecasting in the US (McHenry et al., 2004; McHenry and Dabberdt, 2005). Co-I's include Jay Herman and Christina Hsu at NASA, and Rudy Husar at WU/CAPITA/Lantern Corporation, experts in satellite remote-sensing and aerosol-radiation physics respectively. Key BAMS team members include Carlie Coats and Jeff Vukovich, both of whom have worked with McHenry for years. Christina Hsu developed the "Deep Blue" retrieval algorithm, enabling significant improvements in MODIS AOD retrieval. Montse Fuentes (Consultant) is one of this country's leading experts in spatial data analysis, and Mike Abraczinskas (Collaborator) represents VISTAS. The planned improvements will affect both ozone and haze forecasting through: (1) assimilation of NO2 data; (2) assimilation of AOD data; (3) improved surface relative humidity; (4) reconciliation of land-use information; and (5) improved methods for assimilating real-time fire information. We expect anywhere between a 10-25% improvement in baseline categorical and discrete measures for ozone and perhaps more than that for haze. Project results are expected to make a substantial contribution to NASA's stated objectives for this solicitation fully consistent with NASA's Air Quality management Roadmap. The improved AQF-DSS will provide end-users/decision-makers with increased confidence in mitigating episodic and regional air quality episodes year-round and nationally. Their improved decisions, in turn, will enable reductions in harmful exposures and foster investment in better policy. This will yield socioeconomic savings through improved health while encouraging more effective strategies for long-term sustainable reductions in mean levels of criteria pollutants.

Richard McNider / University of Alabama in Huntsville
Use of Satellite Data to Improve the Physical Atmosphere in SIP Decision Making Models

It is the purpose of this project to employ satellite data in the State Implementation Plan (SIP) modeling process, which defines emission reduction strategies to bring air-pollution levels into compliance with the National Ambient Air Quality Standards (NAAQS). Nationally, tens of billions of dollars in emission-control costs depend on this process. Errors in specifying critical variables of the physical atmosphere, such as temperature, winds, mixing heights, etc., can alter the efficiency and efficacy of emission-control strategies. The aim of using satellite

data is to improve the physical atmosphere in which emission reduction scenarios are evaluated. The target decision-making system (DMS) in this project is the MM5/CMAQ system an EPA-developed photochemical model typical of the SIP modeling systems now used by the states. The prime applied partner in this activity will be NOAA's Atmospheric Modeling Division (AMD) working in partnership with the U.S. EPA's National Environmental Research Laboratory (NERL) in Research Triangle Park, NC. NERL/AMD was the original designer and builder of the CMAQ system. Under this project UAH and its technical partner NASA-MSFC, together referred to as the National Space Science and Technology Center (NSSTC), will transfer satellite assimilation and retrieval techniques developed over the last 18 years under the NASA Earth Science Enterprise (ESE) sponsorship into the MM5/CMAQ system. The physical products include GOES and MODIS albedo, GOES insolation, MODIS land-surface emissivity, retrieval techniques for surface-moisture availability and heat capacity, and procedures for using satellite data for specifying photolysis rates. Also, techniques for using MODIS and GOES skin-temperature data in model evaluation will be transferred and used in the benchmarking phase. Benchmarking will test MM5/CMAQ model performance with and without the satellite products. Model results will be compared to standard NWS observations, special field-program data sets such as the year 2000 Texas Air Quality Study (TEXAQS2000) and ICARTS, and GOES and MODIS satellite skin-temperature products. The project will also develop the infrastructure and support to make these tools and satellite products available to EPA, State and local governments, and the private air-quality consulting community. The benefits to the Nation's air-quality management system will be the availability of an improved model for assessing alternative control strategies, thus avoiding the costs of less effective approaches. Not only can the use of satellite data make SIP control-strategy testing more robust, but by improving model performance it will give more confidence to regulatory agencies and industry that model results can be trusted, thus avoiding SIP delays and litigation.

William Myers / National Center for Atmospheric Research
A Soil Temperature and Moisture Decision Support System for Agriculture

Agriculture is a critical sector of the US economy. Weather events such as hail, high winds, tornados, and flash floods can destroy an entire harvest in a short period of time. Weather conditions, such as long dry spells, long wet spells, and unseasonal temperature variation can take their toll on agriculture over extended periods. Accurate weather forecasts are thus of significant importance to the modern agriculture industry. One of the key areas in

agricultural prediction is the accurate prediction of soil temperature and soil moisture. Precise soil temperature and moisture forecasts are important in the timely application of pesticides as well as efficient irrigation practices. At this time, hundreds of thousands of farmers utilize inadequate soil temperature and moisture forecasts in their decision making process.

Andrew Pershing / Cornell University
Predicting Right Whale Distributions from Space: An Operational System for Marine Ecosystem Modeling

The northern right whale (Eubalaena glacialis) is the most endangered marine mammal currently being protected under United States environmental regulations. The primary cause of human-induced mortality in this species is through entanglement with fishing gear and collisions with ships. Management of this species is the responsibility of NOAA Fisheries (National Marine Fisheries Service), and their management plan depends on knowing where whales are likely to be encountered. Under NOAA funding, we have recently designed and tested the feasibility of predicting whale aggregation areas within the Gulf of Maine using near-real-time satellite data. Our approach is based on the fact that foraging right whales are consistently found in areas where copepods, their primary food source, are abundant. Copepod growth rate is a function of water temperature and phytoplankton concentration which are both observable by satellites. We have received one year of funding from the previous NASA Decision Support CAN to begin building an integrated system solution. The new ISS will couple our copepod model to operational circulation fields derived from a high-resolution assimilative atmosphere-ocean circulation model that has recently been developed for the Gulf of Maine. The suite of models will synthesize information from a variety of earth science observations to provide high resolution estimates of right whale feeding areas. We seek funding through the present NASA CAN under the category of Coastal Management and Ecological Forecasting to further refine the predictive capabilities of this system. Initially, the right whale distribution estimates will be determined from the copepod forecasts by applying a threshold concentration established for Cape Cod Bay. These simple right whale likelihood maps will later be replaced by a prognostic right whale distribution model currently in development. The circulation, zooplankton, and right whale products will be validated by comparing them with available observations. The performance of the complete system and its potential impact on NOAA’s right whale management will be assessed through a quantitative comparison of the high resolution right whale forecasts to the climatological right whale distributions that underlie the current management strategy. Beginning next spring,

data from our project will be incorporated into NOAA's sighting advisory system to describe the environmental conditions surrounding known whale locations. Working with NOAA, we will investigate how our ISS can be used to minimize aerial survey time and to evaluate future management options.

William Reisen / University of California
Integration of Remote Sensing into Encephalitis Virus Intervention Decision Support Systems

Our Integrated System Solutions proposal for Public Health Applications describes the incorporation of NASA models and remote sensing data into a risk assessment model that coalesces environmental, mosquito abundance, and encephalitis virus measurements from the California Mosquito-borne Virus Surveillance and Response Plan (CMVSRP) and the Arbovirus Surveillance Network (ArboNET). The CMVSRP is a decision support system (DSS) currently used by the California Department of Health Services (CDHS) and 53 mosquito and vector control districts (MVCDs) to make intervention decisions regarding West Nile (WNV), St. Louis encephalitis (SLEV) and western equine encephalomyelitis (WEEV) viruses. Data on eight environmental and epidemiological factors are ranked and averaged within the CMVSRP model to produce a real-time estimate of virus risk. CMVSRP users rely on these estimates to make management decisions on pesticide applications for vector control, funding and effort levels for public education and media outreach, and coordination with physicians and emergency services personnel. Within the CMVSRP, the current system used to rank climate variation is not integrated well with mosquito and virus surveillance data. ArboNET is a national reporting and information system operated by the Centers for Disease Control and Prevention (CDC) to document and visualize arbovirus activity reported by state and local health departments. Users include state and local health departments nationwide who rely on ArboNET, in combination with other data sources, to make management decisions related to the initiation of public outreach and media campaigns to encourage the use of preventative measures that may reduce the risk of mosquitoborne virus transmission. We propose to focus initial efforts on enhancing the CMVSRP by effectively integrating NASA models and real-time remote sensing data to accurately define and map current and future mosquito activity and virus transmission risk. Mosquito abundance and risk forecasts based on remote sensing data and validated at a regional scale are likely to be extrapolative to the western United States. Forecasting skill will be evaluated and improved through retrospective simulations using data gathered by ArboNET. Once adequate forecasting skill is developed, our system may be integrated into the suite of maps

available through the CDC WN website to enhance current decision support systems for tracking vector-borne diseases. The integrated DSS will be a model system for the application of NASA products for monitoring and management of vectors and vector-borne diseases, including those new agents which may be introduced inadvertently or purposefully into the U.S.

Gabriel Senay / National Center for EROS

Enhancing the Livestock Early Warning System (LEWS) with NASA Earth-Sun Science data, GPS and RANET technologies.

Conflicts in marginal regions of the Horn of Africa are attributable to competition among pastoral communities for limited resources. The US national interest in the Horn of Africa emanates from the deep commitment of the US to maintain law and order in the region where terrorists can potentially exploit the conflict vulnerability of the population due to harsh climate and competition for water and grazing resources. Monitoring the status of watering holes and rivers is important not only to the pastoralists but also for better management of the environment in terms of land degradation form excessive concentration of livestock during dry times. The Livestock Early Warning System (LEWS) monitors shortfalls in livestock forage resources to support USAID's resource allocation decisions through its Office of Foreign Disaster Assistance (OFDA) programs. We propose to improve the existing LEWS Decision Support System (DSS) by adding a water resources monitoring tool using NASA data. We will characterize and monitor water supply and flood hazards along pastoral migration corridors using ASTER, SRTM and TRMM data, employing a combination of image classification, watershed delineation and hydrologic modeling tools. We propose to map seasonal migration patterns and resource utilization using GPS technology and to distribute resource-status information to migrating pastoral communities using existing satellite-based Radio-Internet (RANET) infrastructure. The synergy of forage monitoring products from LEWS, hydrologic monitoring products from USGS-EROS and the RANET dissemination system forms the basis for a unique integrated framework for producing and delivering information products that end-users at OFDA and in the field can use in making disaster mitigation decisions in near real time. We will produce benchmark reports on the performance of this prototype project on the use of NASA data to address three of NASA's priority application areas: Homeland Security, Disaster Management and Ecological Forecasting to maintain a sustainable ecosystem in developing countries, particularly in Africa.